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(54) **MOUNTING STRUCTURE OF FLEXIBLE PRINTED CIRCUIT BOARD AND SLIDING-TYPE ELECTRONIC DEVICE**

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CPC ***H05K 5/0217*** (2013.01); ***H05K 1/028*** (2013.01); ***H05K 5/0004*** (2013.01); *H04M 1/0237* (2013.01); *H05K 2201/055* (2013.01)

(58) **Field of Classification Search**
CPC H04M 1/0237; H04M 1/026; G06F 1/1624
See application file for complete search history.

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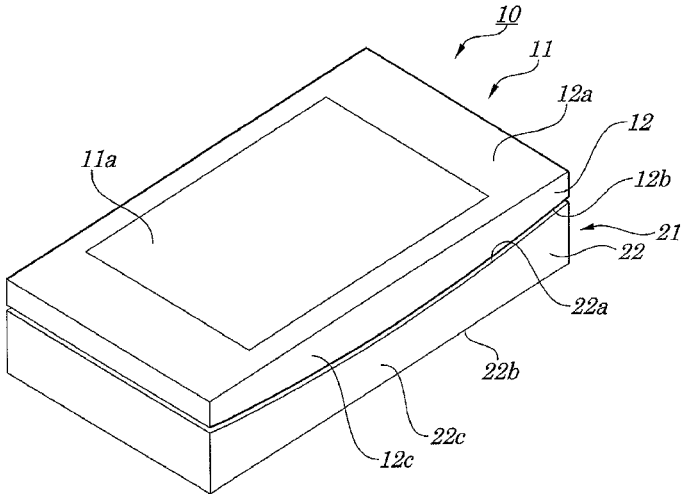
(57) **ABSTRACT**

A mounting structure of a flexible printed circuit board and a sliding-type electronic device is provided by which a too large increase in thickness of devices can be avoided and a pair of housings can be slid relatively in a bending and slanting direction. In the mounting structure, an upper housing **12** and a lower housing **22** coupled in a freely slidable manner are electrically connected to each other by a flexible printed circuit board folded back to be routed between slide facing surfaces **12***b* and **22***a* of both the housings and the height of a side wall surface **12***c* and **22***c* of the upper housing and lower housing changes in a bending manner along the direction of freely sliding and, in the slide facing surfaces of the upper housing and lower housing, concave space portions **15** and **25** to accommodate the change in curvature and in position of a folding-back portion **31***a* caused by sliding motion between the upper housing and lower housing are disposed.

4 Claims, 10 Drawing Sheets



(51) **Int. Cl.**
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H04M 1/02 (2006.01)

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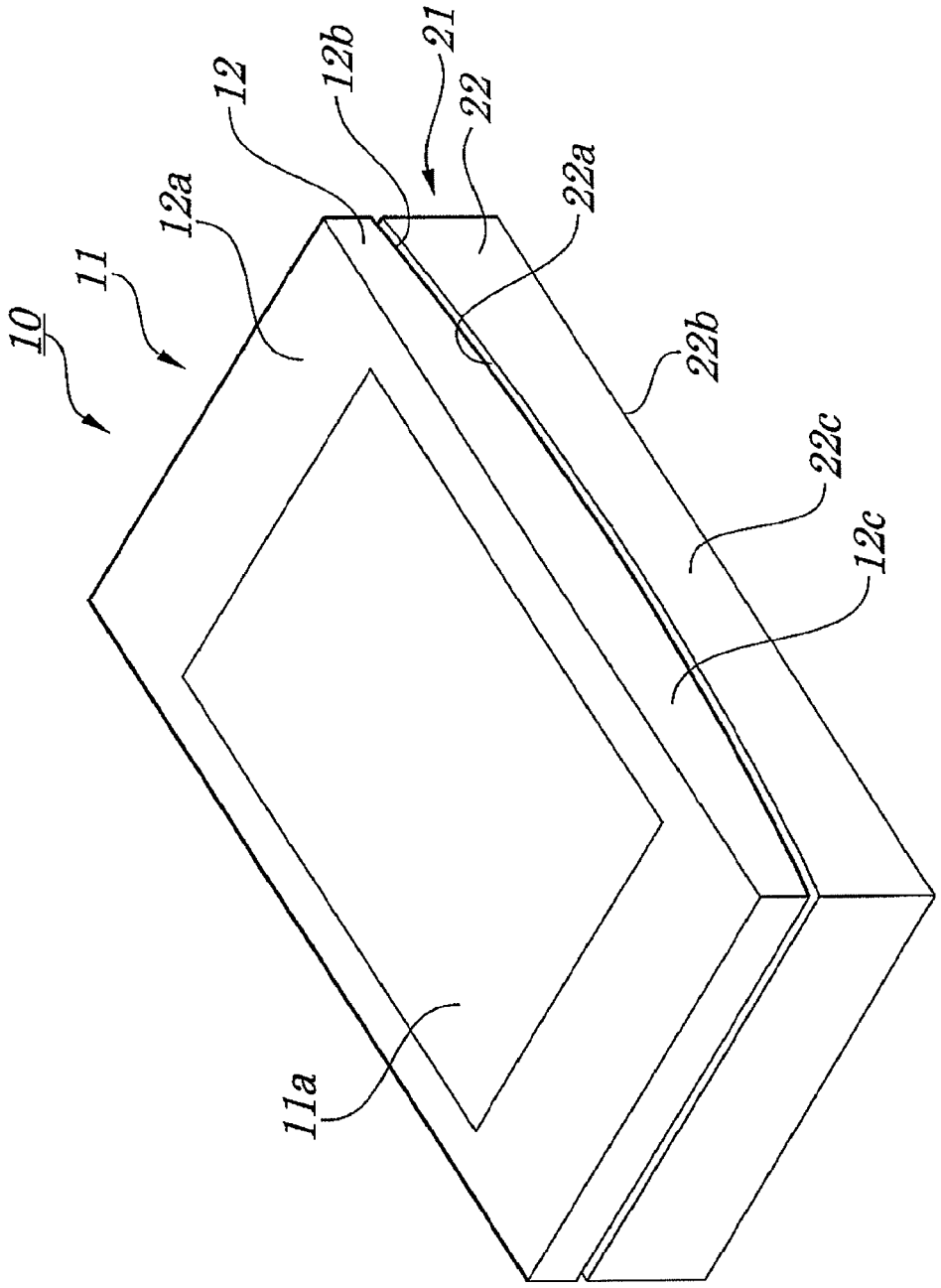
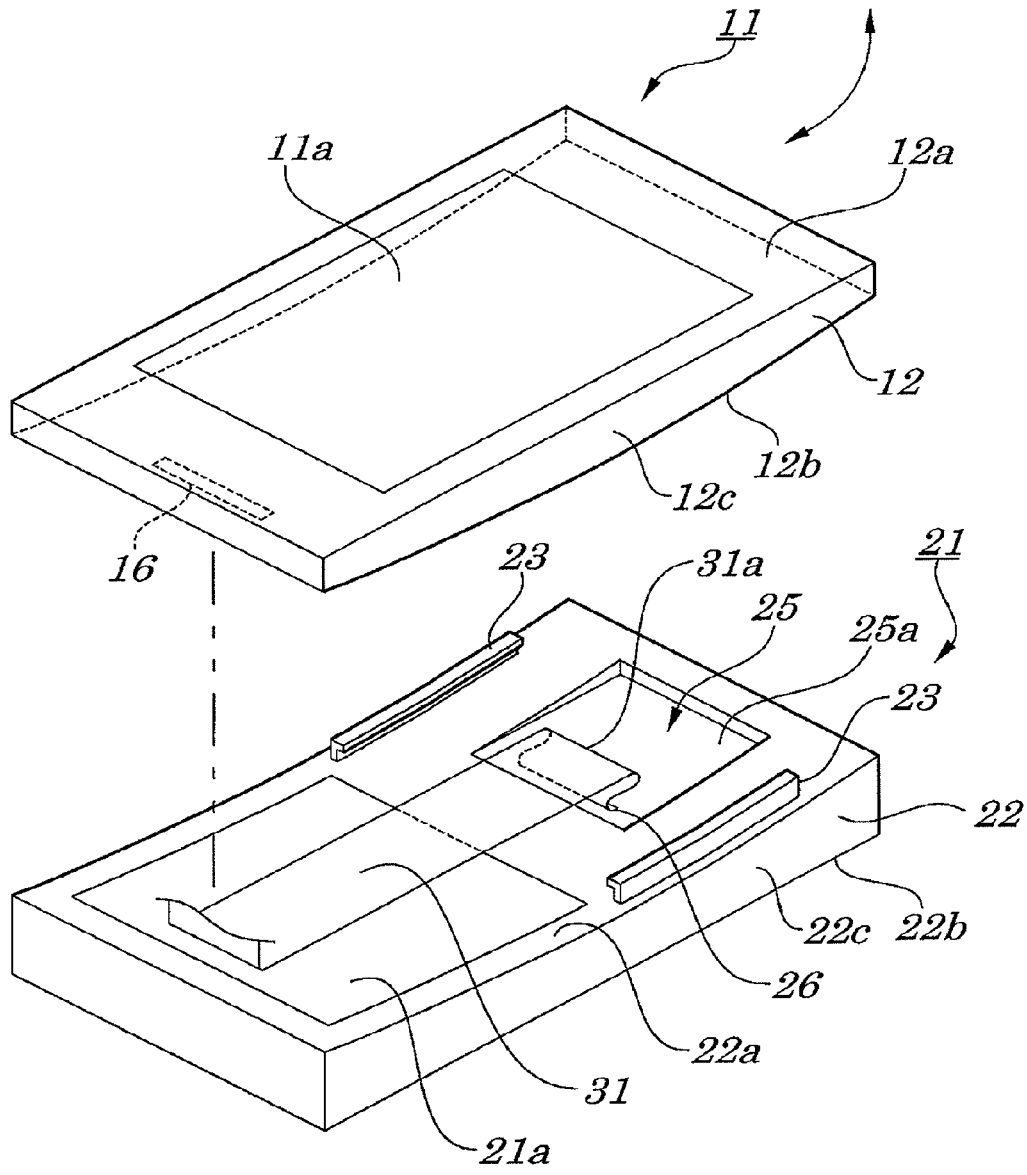


FIG.1

FIG.2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12
12b
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22a
31
21a

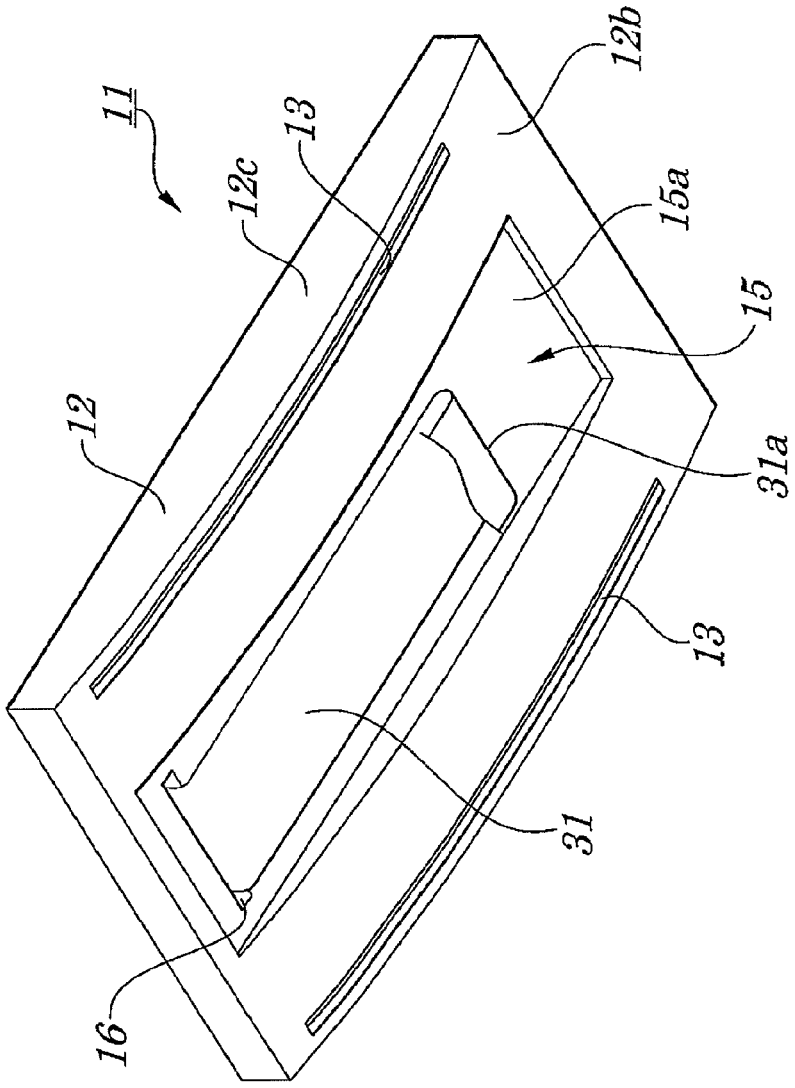
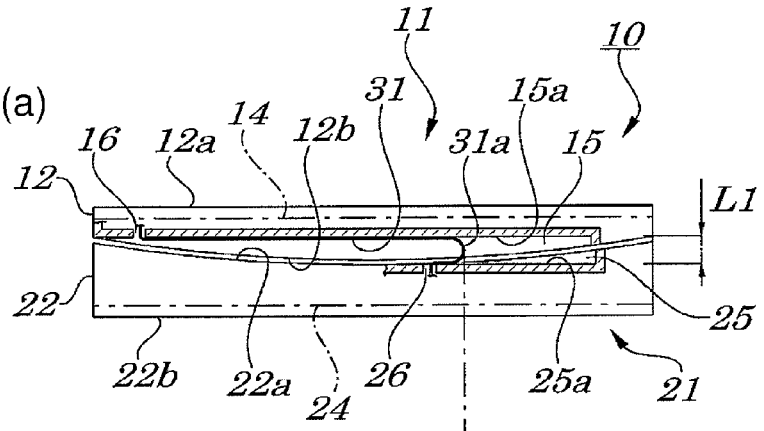


FIG.3

FIG. 4 (a)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10
31
15a
14
16
12a
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31a
15
12
L1
22
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22a
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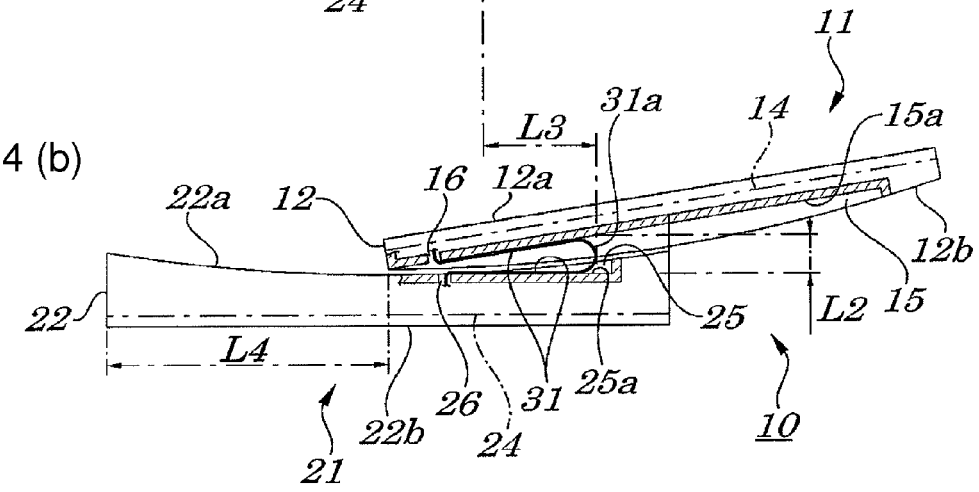
25a
21

FIG. 4 (b)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L4
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25a
10
22b
24
21

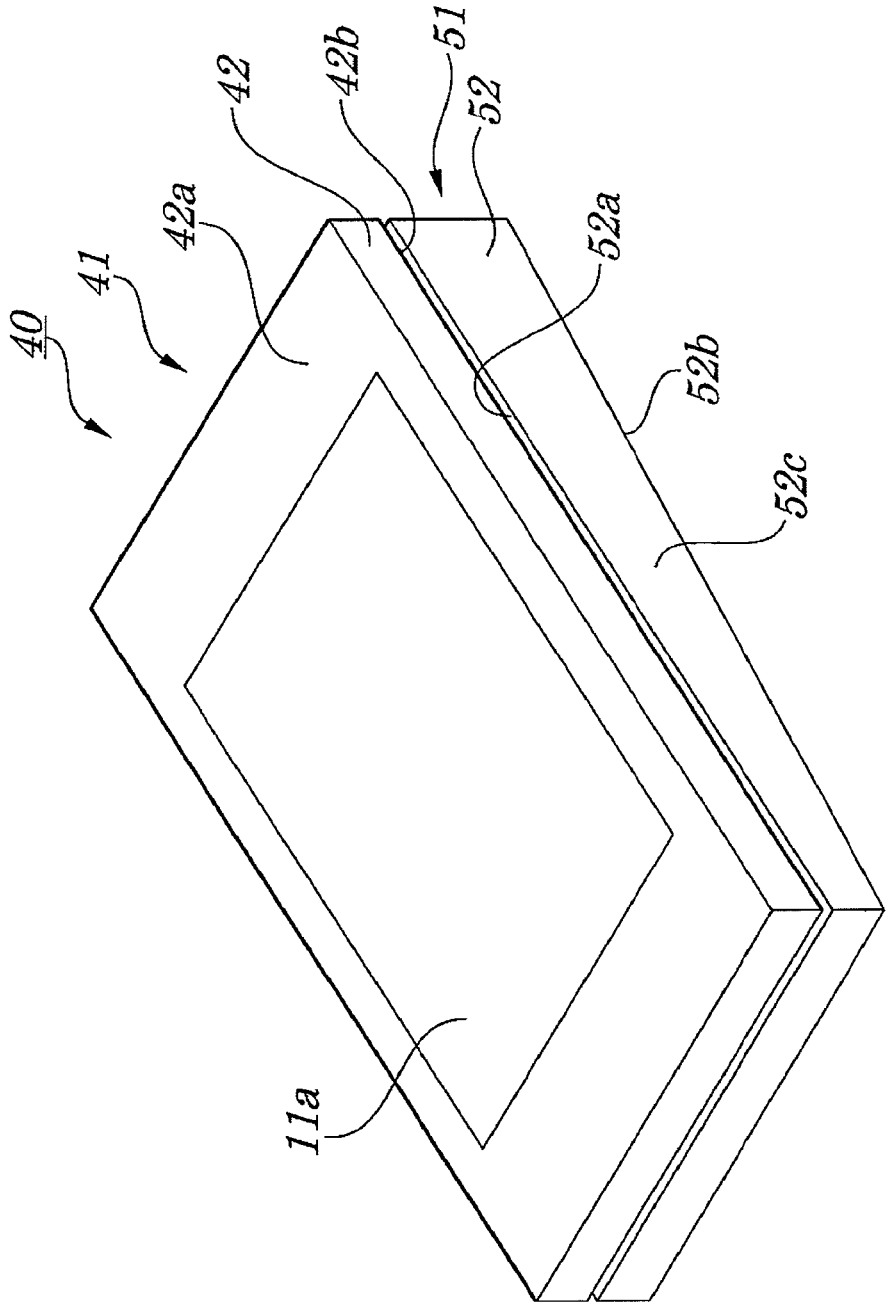

FIG.5

FIG. 6 (a)

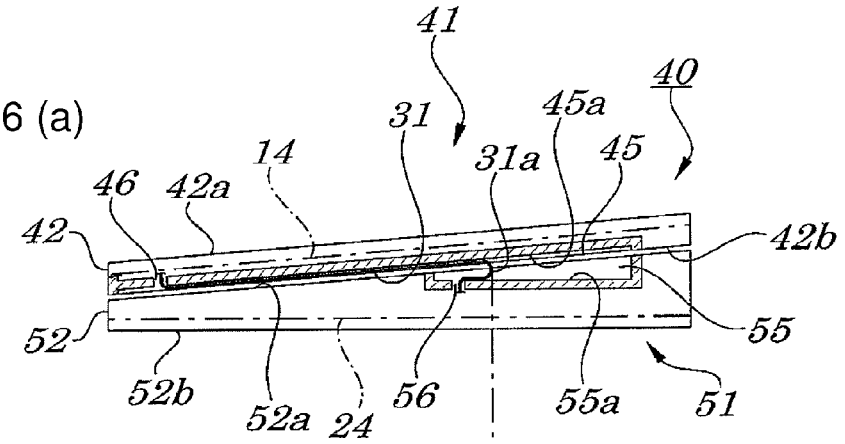
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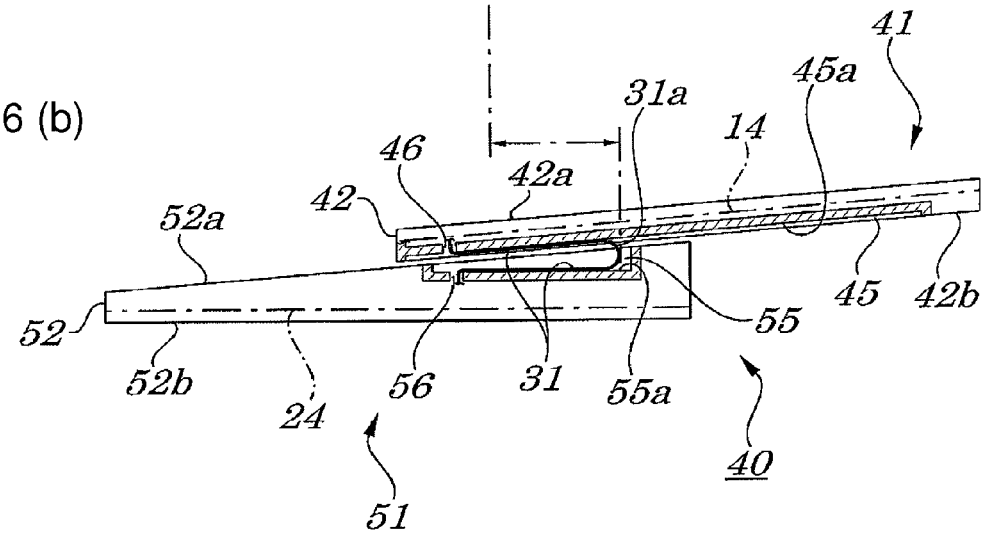
FIG. 6 (b)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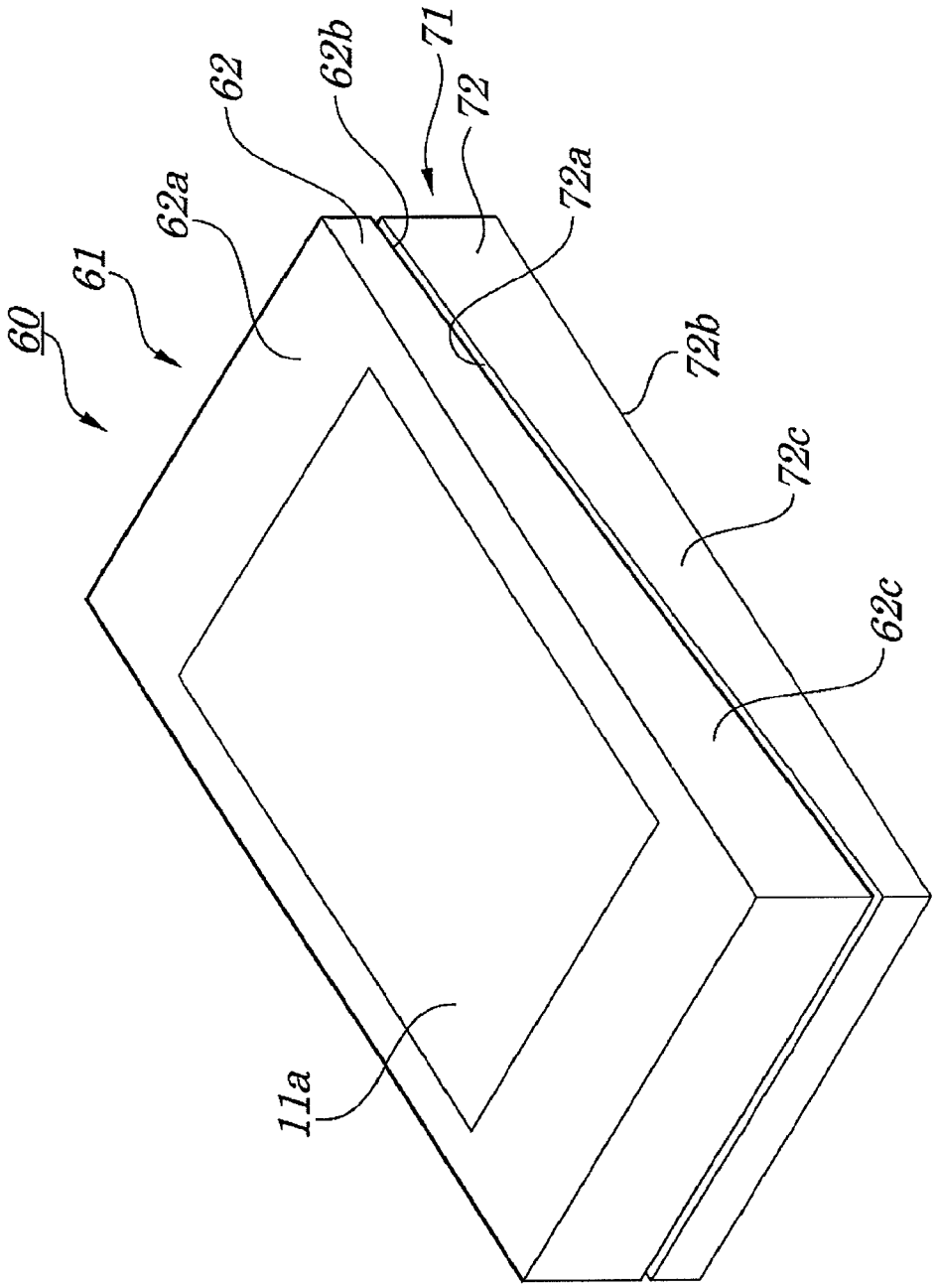
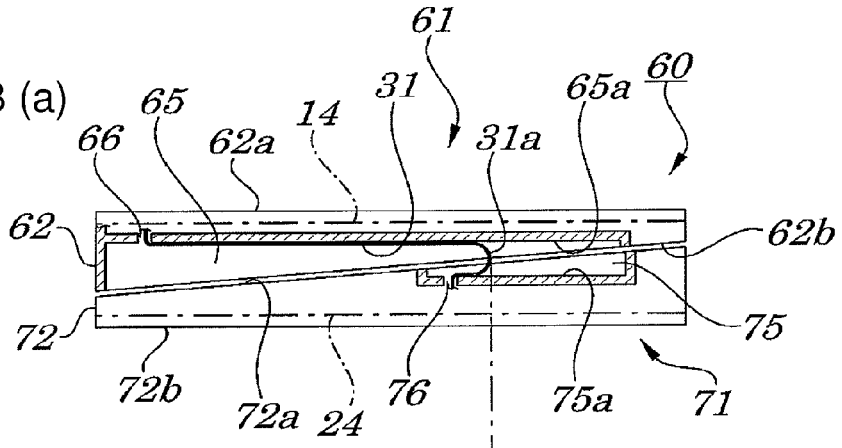


FIG. 7

FIG. 8 (a)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65
31
65a
60
66
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31a
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62b
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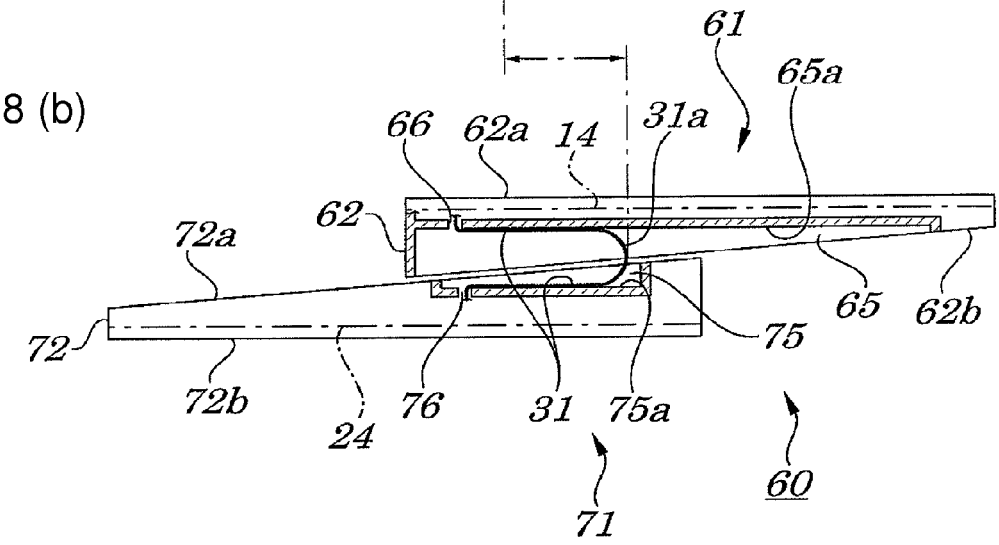
71

FIG. 8 (b)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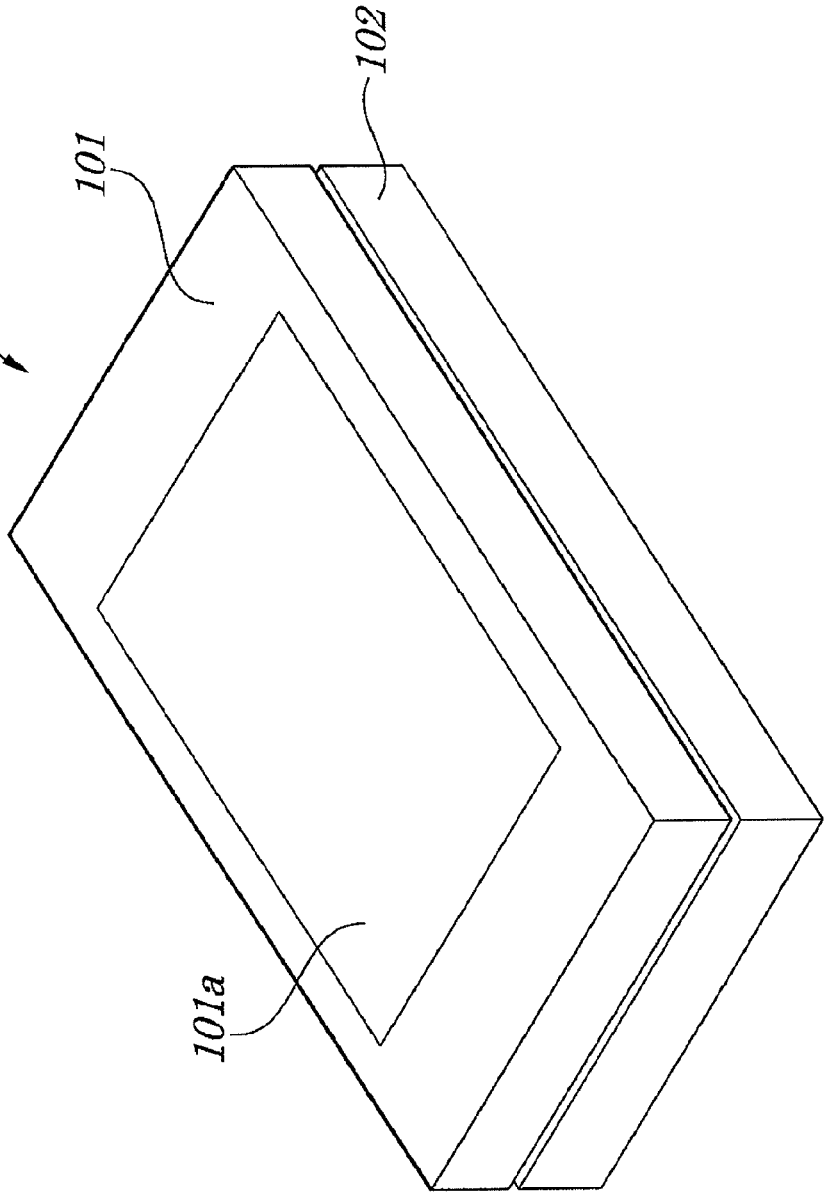


FIG. 9 (RELATED ART)

FIG. 10 (a)
(RELATED ART)

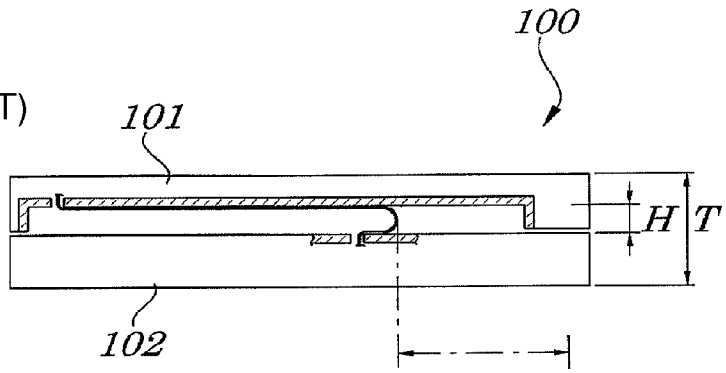
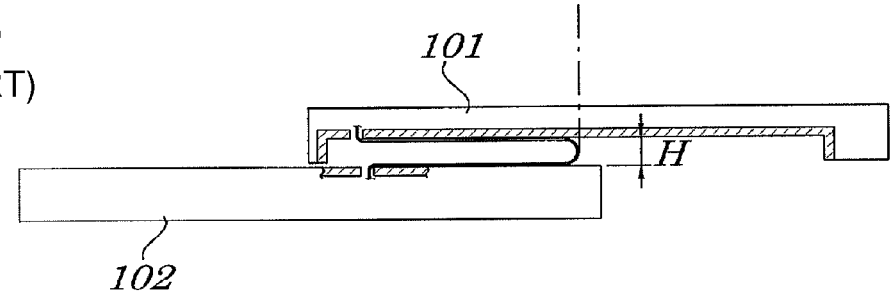


FIG. 10 (b)
(RELATED ART)



MOUNTING STRUCTURE OF FLEXIBLE PRINTED CIRCUIT BOARD AND SLIDING-TYPE ELECTRONIC DEVICE

CROSS-REFERENCE TO RELATED APPLICATION

This application is a Continuation of U.S. application Ser. No. 13/130,449, filed May 20, 2011, which is a national stage entry of PCT/JP2009/005934, filed Nov. 6, 2009, claiming priority based on Japanese Patent Application No. 2008-299082, filed Nov. 25, 2008, the disclosures of which are incorporated herein by reference in their entirety.

TECHNICAL FIELD

The present invention relates to a mounting structure of a flexible printed circuit board and a sliding-type electronic device and more particularly to the mounting structure of the flexible printed circuit board being able to house, in a compact manner, the flexible printed circuit board between slide facing surfaces of housings that slide in a direction relative to each other and the sliding-type electronic device.

In electronic devices being available recently, for example, some devices are configured so that a display section and an operation section are disposed in separate housings and a pair of housings is coupled in a freely slidable manner. In the sliding-type electronic devices, by making the operation section hidden on a rear side of the display section at time of not using the device and by making the operation section exposed so as to be operable for inputting at time of using the device, limitation of careless inputting operation and compactness of the devices are achieved.

In the sliding-type electronic device of this type, it is necessary that circuit boards mounted in the pair of sliding housings are electrically connected to each other by using a flexible printed circuit (FPC) board. The FPC board is configured, by setting its length to be longer than the minimum length required to connect between circuit boards of the both housings to form a folding-back portion (folding-back section), so as to follow the sliding motion relative to each other between housings without the occurrence of the breaks of the FPC board and to maintain a connection state (for example, Related Art Patent Reference 1).

Incidentally, there is a proposal that a structure in which a display portion and an operation portion are connected in a bending surface of the FPC board is to be applied to an electronic device having the display portion and operation portion, in particular, to a portable type electronic device such as a mobile phone (for example, Related Art Patent Reference 2). Moreover, in the mobile phone of the above type, by employing the structure in which the operation portion being connected to the display portion is opened or closed by the sliding of the cover, careless inputting operation can be limited.

RELATED ART DOCUMENT

Related Art Patent References

Related Art Patent Reference 1: WO2006/095382

Related Art Patent Reference 2: Japanese Patent Application Laid-open Hei9-247252

SUMMARY OF INVENTION

Problems to be Solved by the Invention

However, the sliding-type electronic device disclosed in the Related Art Patent Reference 1 has a problem in that areas occupied by internally mounted various components caused by miniaturization and thinning and functional increases tend to increase. Moreover, as shown in FIGS. **9**, **10**(*a*) and **10**(*b*), in the sliding-type electronic device **100** such as a mobile phone in which a housing **101** having a display portion **101***a* and a housing **102** having an operation portion (not shown) are coupled to each other in a freely sliding manner through a sliding mechanism, it is necessary to prepare a space **120** to mount an FPC board **110** between the pair of housings **101** and **102** so that the space **120** extends with a predetermined height H in a sliding direction. The sliding-type electronic device **100** has another problem in that, in order to achieve its miniaturization and thinning and to decrease a ratio of the height H of the mounting space **120** to a whole thickness T, if a bending radius of a folding-back portion of the FPC board **110** is made small (if curvature is made large), the durability of the FPC board **110** decreases due to sliding motion for opening and closing, resulting in a break of the FPC board **110**.

On the other hand, the Related Art Patent Reference 2 discloses another mobile phone in which, if, by making the most of the posture relative to each other between a display portion and an operation portion, for example, the posture of a housing on the display portion side, which has slid over the housing on the operation side, is inclined in a direction of rising, useless space is provided. That is, since the facing surface that faces a side of a housing having circuit boards is bent, space for bending is required.

In other words, in the case of a mechanism in which a pair of housings is slid on each other in a bending direction, it is necessary to ensure sufficient space to mount the FPC board and to slide one housing over another housing, resulting in increased thickness on the whole.

In view of the above, an object of the present invention is to provide a mounting structure of the flexible printed circuit board and a sliding-type electronic device which is able to slide a pair of housings in a bending direction relative to each other without causing a large increase in thickness of a device.

Means for Solving the Problems

To solve the above problems, the configuration of the present invention is characterized in that a mounting structure of a flexible printed circuit board including a flexible printed circuit board routed between slide facing surfaces of a first housing and a second housing both being mechanically coupled to each other in a manner being freely slidable to electrically connect the first and second housings wherein a height making up a sidewall surface of at least one of the first and second housings changes along a freely slidable direction and a concave space portion on a slide facing surface making up at least one of the first and second housings to accommodate a flexible change in shape of the flexible printed circuit board caused by sliding motion between the first and second housings.

Effects of Invention

According to the configuration of the present invention, the flexible printed circuit board can flexibly change its shape depending on sliding motion in concave space portions disposed on slide facing surfaces of housings a height on a wall side of which changes. Therefore, it is not necessary to separately provide space in which the height of the side wall surface and space to accommodate a flexible change in shape caused by sliding motion of the flexible printed circuit board

and thus miniaturization and thinning can be achieved without causing unnecessary increased thickness of a device.

BRIEF DESCRIPTION OF DRAWINGS

FIG. **1** is a perspective view showing a mobile phone being a portable type electronic device having a sliding mechanism of a first exemplary embodiment of the present invention.

FIG. **2** is a separate perspective view showing the configuration of an upper housing and lower housing of the mobile phone of the first exemplary embodiment of the present invention.

FIG. **3** is a perspective view showing the configuration of the upper housing of the mobile phone of the exemplary embodiment of the present invention.

FIGS. **4**(*a*) and **4**(*b*) are drawings showing sliding motion of the mobile phone of the exemplary embodiment of the present invention and FIG. **4**(*a*) is a side surface perspective view showing a state before the sliding motion and FIG. **4**(*b*) is a side surface perspective view showing a state after the sliding motion.

FIG. **5** is a perspective view showing a mobile phone being a portable electronic device having a sliding mechanism of the second exemplary embodiment of the present invention.

FIGS. **6**(*a*) and **6**(*b*) are diagrams explaining sliding motion of the mobile phone and FIG. **6** (*a*) is a side perspective view showing a state before the sliding motion and FIG. **6** (*b*) is a side perspective view showing a state before the sliding motion.

FIG. **7** is a perspective view showing a mobile phone being a portable electronic device having a sliding mechanism of the third exemplary embodiment of the present invention.

FIGS. **8**(*a*) and **8**(*b*) are diagrams explaining sliding motion of the mobile phone and FIG. **8**(*a*) is a side perspective view showing a state before the sliding motion and FIG. **8**(*b*) is a side perspective view showing a state after the sliding motion.

FIG. **9** is a perspective view showing a mobile phone having a sliding mechanism of the related technologies; and

FIGS. **10**(*a*) and **10**(*b*) are diagrams explaining sliding motion of the mobile phone and FIG. **10**(*a*) is a side perspective view showing a state before the sliding motion and FIG. **10**(*b*) is a side perspective view showing a state after the sliding motion.

BEST MODE OF CARRYING OUT THE INVENTION

A mounting structure of a flexible printed circuit board is provided in which a first housing and a second housing mechanically coupled each being freely slidable are electrically connected by a flexible printed circuit board folded back to be routed between sliding surfaces of the both housings facing each other, characterized in that a height of a side wall surface making up at least one of the first and second housings changes in a bending or slanting manner along the direction of free sliding and that a concave space portion is provided on the sliding surface making up at least one of the first and second housings to accommodate a flexible change in shape of a curvature of folding-back of the flexible printed circuit board and its folding-back position or the like caused by sliding motion of the first and second housings. Hereinafter, exemplary embodiments of the present invention are described in detail by referring to drawings.

First Exemplary Embodiment

FIGS. **1** to **4**(*b*) are diagrams respectively showing one example of a mobile phone to which a sliding-type electronic device having amounting structure of a flexible printed circuit board of a first exemplary embodiment of the present invention is applied. FIG. **1** is a perspective view of an outward appearance of the mobile phone. FIG. **2** is a separate perspective view, as seen from an upper slanting direction, of a first housing and a second housing making up the portable phone. FIG. **3** is a separate perspective view, as seen from a lower slanting direction, of the first housing. FIGS. **4**(*a*) and **4**(*b*) are side transparent views showing the flexible printed circuit board to which a circuit board is connected during a sliding operation of the first and second housings.

As shown in FIG. **1**, the mobile phone **10** is so configured that an upper unit **11** and a lower unit **21** are coupled by the flexible printed circuit board **31** (hereinafter, may be simply referred to as an FPC board) **31** which are shown in detail later in FIG. **2** and other and in a manner in which the upper and lower units **11** and **21** can overlie each other in the shape of thin rectangular parallelepiped. The mobile phone **10** is also configured so that the upper unit **11** faces the lower unit **21** and a lower surface **12***b* of the upper housing **12** of the upper unit **11** can be coupled to an upper surface **22***a* of the lower housing **22** of the lower unit **21** in a manner in which the lower surface **12***b* and upper surface **22***a* can be freely slid in a longitudinal direction with these two surfaces **12***b* and **22***a* facing each other. In the upper unit **11**, a display portion **11***a* to display various information is disposed on approximately the whole upper surface **12***a* of the upper housing **12**. In the lower unit **21**, an operation section **21***a* to perform an operation to input various information is disposed (see FIG. **2**) in a region on the upper surface **22***a* of the lower housing **22** that exposes after having slid the upper unit **11** (see FIG. **2**). The mobile phone **10** is so configured as to relatively slide the upper unit **11** and lower unit **21** in a longitudinal direction to open or close the operation section **21***a* in an operable or inoperable manner and, by using a relative slide-open operation direction of the upper housing **12** and lower housing **22** as a reference, each of the configurations on a tip end side and on a rear end side is described (This can be applied to other exemplary embodiments described below).

In the upper unit **11**, a height of the side surface (side wall portion) of the upper housing **12** changes in a bending manner in a direction in which the upper housing **12** freely slides (simply referred to as a sliding direction) and the lower surface **12***b* bends in a longitudinal direction of the rectangular parallelepiped and extrudes in a convex shape. Similarly, in the lower unit **21**, a height of the side surface (side wall portion) of the lower housing **22** changes in a bending manner in a direction in which the lower housing **22** slides and the upper surface **22***a* bends in a longitudinal direction of the rectangular parallelepiped and is recessed in a concave shape. Each of cross-sections of the lower surface **12***b* and upper surface **22***a* is so formed as to be similar to each other and to face each other in a state coming near to each other. In the lower housing **22**, as shown in FIG. **2**, extruding rails **23** each having its cross-sectional shape of a key-shaped track are formed along both sides of the upper surface **22***a* in a longitudinal direction, which extends by a length being a half of a length of a longitudinal direction of the upper surface **22***a*. On the other hand, in the upper housing **12**, as shown in FIG. **3**, grooved rails **13** each having its cross-sectional shape of a key-shaped track are formed along both sides of the lower surface **12***b* and extend by a whole length of a longitudinal direction of the lower surface **12***b*. Cross-sectional shapes of the extruding rails **23** and cross-sectional shapes of grooved rails **13** are respectively formed so as to be similar to one another so that these rails **13** and **23** are fitted in an engaged state to be slidable and are coupled to one another.

In the mobile phone **10**, by fitting the extruding rails **23** into the grooved rails **13**, as shown in FIGS. **4**(*a*) and **4**(*b*), the upper housing **12** and lower housing **22** are allowed to be relatively slid toward bent portions in the longitudinal direction of the rails **13** and **23** in a state being kept in which the lower surface **12***b* of the upper housing **12** comes near to the upper surface **22***a* of the lower housing **22**. That is, the grooved rail **13** and extruding rail **23** make up a sliding mechanism and the lower surface **12***b* of the upper housing **12** and lower surface **22***a* of the lower housing **22** make up a slide facing surface. Then, by relatively sliding the upper unit **11** and lower unit **21**, which have overlain each other, toward the "open" direction, the operation section **21***a*, which has remained hidden in a state facing the lower surface **12***b* of the upper housing **12**, on the tip end side where there is no extruding rail **23** disposed on the upper surface **22***a* of the lower housing **22** is allowed to be exposed to perform inputting operations. At this time point, the lower surface **12***b* of the upper housing **12** bending in a convex shape is slid over the upper surface **22***a* of the lower housing **22** bending in a concave shape to allow the display portion **11***a* disposed on the side of the upper surface **12***a* to be put into operation. In other words, the display portion **11***a* is in a state being risen from the operation section **21***a* on the upper surface **22***a* side of the lower housing **22** and, therefore, a face angle at the display portion **11***a* facing a user can be made larger which can improve visibility, compared when the operation section **21***a* is positioned on a plane surface on which an operation surface of the operation section **21***a* is extended.

In the upper unit **11** and lower unit **21**, as shown in FIGS. **2** and **3**, the FPC board **31** being in a state folded back to be routed from a drawing-out port **16**, in a shape of an aperture, formed in the lower surface **12***b* of the upper housing **12** and a drawing-out port **26**, in a shape of an aperture, formed in the upper surface **22***a* of the lower housing **22** is inserted into an inner space between the upper housing **12** and lower housing **22** to supply electricity between circuit substrates **14** and **24** (see FIGS. **4**(*a*) and **4**(*b*)) to be mounted internally. That is, the FPC board **31** is drawn from the drawing-out ports **16** and **26**, in a shape of an aperture, respectively formed on the lower surface **12***b* of the upper housing **12** and formed on the upper surface **22***a* of the lower housing **22** and its folding-back section **31***a* is positioned between slide facing surfaces, thus allowing the upper unit **11** and lower unit **21** to be slid in a longitudinal direction.

More specifically, in the upper unit **11**, a concave space portion **15** is formed through approximately the whole length from a portion near to the tip end side to a portion near to the rear end side in a longitudinal direction of the lower surface **12***b* of the upper housing **12** bending in a convex shape. The concave space portion **15** is so formed as to have a bottom surface **15***a* being parallel to the circuit substrate **14** and upper surface **12***a* and a recessed shape being wider in width than the FPC board **31** and the drawing-out port **16** of the FPC board **31** is formed, in a shape of an aperture, on the rear end side. On the other hand, in the lower unit **21**, a concave space portion **25** is formed from a portion near to the rear end side to a portion near to a lowest bottom portion in the proximity of a concave-shaped central portion in the longitudinal direction of the upper surface **22***a* of the lower housing **22** bending in the concave shape. The concave space portion **25** is so formed as to have a bottom surface **25***a* being parallel to the circuit substrate **24** and the upper surface **22***a* and a recessed shape being wider in width than the FPC board **31** and a drawing-out port **26** of the FPC board **31** is formed, in a shape of an aperture, on the tip end side (near the front). That is, the drawing-out port **16** of the upper housing **12** and the drawing-out port **26** of the lower housing **22** are formed on the end portion of the concave space portions **15** and **25** so that the drawing-out ports **16** and **26** are not exposed to the outside even in the case of the state where the upper unit **11** and lower unit **21** overlie each other or even in the case of the state where the upper unit **11** is slid over the lower unit **21** to the maximum. Moreover, the drawing-out port **26** of the lower housing **22** is formed at a place facing the drawing-out port **16** of the upper housing **12** in an opened state where the drawing-out port **26** is slid to the maximum.

On the other hand, on the upper unit **11** side, the FPC board **31** extends, after being drawn from the drawing-out port **16** formed, in a shape of an aperture, on the rear end side of the concave space portion **15** of the upper housing **12**, up to the tip end side (up to over a portion near to a central portion) of the concave space portion **25** of the lower housing **22** facing the tip end portion of the concave space portion **15**. The FPC board **31** on the lower unit **21** extends, after being drawn out from the drawing-out port **26** formed on the tip end side of the concave space portion **25** of the lower housing **22**, up to the rear end side. The FPC board **31** has the folding-back portion **31***a* which is formed by being extended in the same direction between the tip end side of the concave space portion **15** on the upper unit **11** side and the rear end side of the concave space portion **25** on the lower unit **21** side.

Therefore, as shown in FIG. **4**(*a*), the folding-back portion **31***a* of the FPC board **31**, at the time of the closing state where the upper unit **11** and the lower unit **21** overlie each other, is positioned near to a portion on the rear end portion of the drawing-out port **26** of the concave space portion **25** and is housed in the concave space portions **15** and **25**. That is, the FPC board **31** is positioned in most of the area of the concave space portion **15** of the upper housing **12** and, therefore, the folding-back portion **31***a* bends in a curvature that provides no load and its dimensions are set so that the distance between the bottom surface **15***a* and lower surface **12***b* falls within a maximum interval distance L**1**.

Moreover, at the time of the opened state in which the upper unit **11** is slid over the lower unit **21** at the maximum, the folding-back portion **31***a* of the FPC board **31**, as shown in FIG. **4**(*b*), moves from a portion near to the drawing-out port **26** of the concave space portion **25** toward the rear end side and is housed in the concave space portions **15** and **25**. That is, as the drawing-out port **16** of the upper housing **12** is slid over the tip end portion (approaching the drawing-out port **26** of the lower housing **22**), the FPC board **31** existing between the drawing-out ports **16** and **26** changes the position where the folding-back portion **31***a* is formed so as to be positioned on the rear end side in the concave space portion **15** corresponding to a portion near to a central portion of the concave space portion **25** and, therefore, the dimensions are set so as to prevent the exposure toward the outside.

Therefore, at the time of the opened state in which the upper unit **11** is slid over the lower unit **21** to allow the operation section **21***a* to be exposed, by positioning the FPC board **31** in the concave space portion **15** of the upper housing **12** and in the concave space portion **25** of the lower housing **22**, the distance between the bottom surface **15***a* and lower surface **25***b* falls within the distance L**2** obtained by adding space distance on the concave space portion **25** side to the distance L**1** obtained when the upper unit **11** and lower unit **21** overlie each other. Therefore, when the upper unit **11** is slid over the lower unit **21**, by changing the shape of the folding-back portion **31***a* so as to be bent gently in a curvature that provides less load, the connected state between the circuit substrates **14** and **24** can be maintained. Moreover, by using the FPC board **31**, the sliding distance falls within the short

distance L3 being shorter than a sliding distance L4 of the upper unit **11** and, therefore, a large exposure area on the tip end side of the lower unit **21** can be taken, which makes it possible to ensure a larger area of the operation section **21***a*.

The FPC board **31** moves the folding-back portion **31***a* and changes its shape outside the drawing-out ports **16** and **26** of the upper housing **12** or the lower housing **22** (that is, the use of the drawing-out ports **16** and **26** is not required for inputting and outputting) and, therefore, it is made possible to seal portions other than the drawing-out ports **16** and **26** of the upper housing **12** and lower housing **22** or to block the drawing-out ports **16** and **26**, which can improve dust resistance.

Thus, according to the first exemplary embodiment, the concave space portions **15** and **25** are formed respectively on the lower surface **12***b* of the upper housing **12** and on the upper surface **22***a* of the lower housing **22** both being the slide facing surfaces between the upper unit **11** and lower unit **21** both being relatively slid in a bending direction and, therefore, the folding-back portion **31***a* of the FPC board **31** can be housed in the above concave space portions **15** and **25**. As a result, space among the lower surface **12***b*, upper surface **22***a*, and circuit substrates **14** and **24** can be used effectively without producing dead space, which ensures mounting space (distances L1 and L2) required for durability of the FPC board **31** therein without providing another space separately. Thus, in the first exemplary embodiment employing the structure allowing the upper unit **11** to be slid over the lower unit **21** in a slanting direction and allowing miniaturization and thinning of the mobile phone to be achieved, as a result, a user performing operations of the operation section **21***a* can see visually and easily the display portion **11***a*.

Second Exemplary Embodiment

FIGS. **5**, **6**(*a*), and **6**(*b*) are diagrams showing one example of a mobile phone of a second exemplary embodiment employing a sliding-type electronic device having a mounting structure of an FPC board of the present invention. FIG. **5** is a perspective view showing an outward appearance of the mobile phone. FIGS. **6**(*a*) and **6**(*b*) are side transparent views showing the FPC board to connect circuit substrates while first and second housings are in a sliding operation. Since the structure of the second exemplary embodiment is the same as the above first exemplary embodiment, in FIGS. **5**, **6**(*a*), and **6**(*b*), same reference numbers are assigned to same parts (this applies to other exemplary embodiments).

As shown in FIGS. **5**, **6**(*a*), and **6**(*b*), as in the above first exemplary embodiment, the mobile phone **40** is configured so that an upper unit **41** is coupled to a lower unit **51** by an FPC board **31** and that the upper and lower units **41** and **51** can overlie each other in a manner in which the upper surface of the mobile phone **40** is inclined in a thin box-like structure. The mobile phone **40** is also configured so that the upper unit **41** faces the lower unit **51** and a lower surface **42***b* of an upper housing **42** of the upper unit **41** can be coupled to an upper surface **52***a* of a lower housing **52** of the lower unit **51** in a manner in which a lower surface **52***b* and an upper surface **42***a* can be freely slid in a longitudinal direction with the two surfaces **42***b* and **52***a* facing each other. In the upper unit **41**, a display portion **11***a* to display various information is disposed on approximately the whole upper surface **42***a* of the upper housing **42**. In the lower unit **51**, an operation section (not shown) to perform an operation to input various information is disposed in a region on the upper surface **52***a* of the lower housing **52** exposing after having slid the upper unit **41**.

The height of the side surface (side wall portion) **52***c* of the lower housing **52** of the lower unit **51** changes along the slant-inclined upper surface **52***a* rising toward the rear end side. The upper surface **42***a* and lower surface **42***b* of the upper housing **42** of the upper unit **41** are slant-inclined in parallel to the upper surface **52***a* of the lower housing **52** and the lower surface **42***b* of the upper housing **42** faces the upper surface **52***a* of the lower housing **52** in a state being in close contact with each other. On the lower surface **42***b* of the upper housing **42** and on the upper surface **52***a* of the lower housing **52**, as in the above first exemplary embodiment, grooved rails each having its cross-sectional shape of a key-shaped track and extruding rails are formed and the lower surface **42***a* and upper surface **52***a* can be slid, in a state in which the lower and upper surfaces face each other, relatively in a longitudinal direction (in a slanting direction). That is, when the upper unit **41** and lower unit **51** are slid relatively from a closed state where the units **41** and **51** overlie each other to an opened state, the operation section on the upper surface **52***a* of the lower housing **52** can be exposed so as to be operable for inputting from a state being hidden against the lower surface **42***b* of the upper housing **42**. Moreover, a face angle at the display portion **11***a* facing a user can be made larger which can improve visibility, compared when the display portion **11***a* on the upper housing **42** is slid in a horizontal direction.

In the upper unit **41**, a concave space portion **45** is formed through approximately the whole length from a portion near to the tip end side to a portion near to the rear end side in a longitudinal direction of the lower surface **42***b* of the upper housing **42** bending in a concave shape. The concave space portion **45** is so formed as to have a bottom surface **45***a* being parallel to a circuit substrate **14** and the upper surface **42***a* and a recessed shape having a depth enough to house the FPC board **31** and a drawing-out port **46** of the FPC board **31** is formed, in a shape of an aperture, on the rear end side. On the other hand, in the lower unit **51**, a concave space portion **55** is formed from a portion near to the rear end side to the central portion in a longitudinal direction of the upper surface **52***a* of the lower housing **52**. The concave space portion **55** is so formed as to have some depth on its tip end portion and have a bottom surface **55***a* being parallel to a circuit substrate **24** and the lower surface **52***b* and a recessed shape being wider in width than the FPC board **31** and a drawing-out port **56** of the FPC board **31** is formed, in a shape of an aperture, on the tip end side (front side). That is, even in the case of the closed state where the upper unit **41** and lower unit **51** overlie each other or even in the case of the opened state where the upper unit **41** is slid over the lower unit **51** to the maximum, the drawing-out port **46** of the upper housing **42** and the drawing-out port **56** of the lower housing **52** are formed in end portions of the concave space portions **45** and **55** so that the drawing-out ports **46** and **56** are not exposed to the outside. Moreover, when the upper unit **41** is slid over the lower unit **51** to the maximum, the drawing-out port **56** of the lower housing **52** and the drawing-out port **46** of the upper housing **42** are so formed as to face each other.

On the other hand, the FPC board **31**, on the upper unit **41** side, after being drawn from the drawing-out port **46** formed on the rear end side of the concave space portion **45** of the upper housing **42**, extends up to the tip end side (up to a portion near to a central position) of the concave space portion **55** of the lower housing **52** facing on the tip end side of the concave space portion **45**. The FPC board **31** on the lower unit **51**, after being drawn from the drawing-out port **56** formed on the tip end side of the concave space portion **55** of the lower housing **52**, extends up to the end side. Then, the FPC board **31** extends in the same direction on the tip end side of the concave space portion **45** on the upper unit **41** side and

on the rear end side of the concave space portion **55** of the lower unit **51** side to be folded back so that a folding-back portion **31***a* is formed.

Therefore, the FPC board **31**, as shown in FIG. **6**(*a*), in the case of the closed state where the upper unit **41** and lower unit **51** overlie each other, the folding-back portion **31***a* is positioned in a portion near to the rear end side of the drawing-out port **56** of the concave space portion **55** and is to be housed in the concave space portion **55**. That is, the folding-back portion **31***a* is positioned in a portion near to the rear end side of the concave space portion **55** and, therefore, by forming the concave space portion **55** so as to be deeper from its tip end side than the case of the above exemplary embodiment, the folding-back portion **31***a* is allowed to bend in a curvature that provides no load and its dimensions are so set as to be housed therein.

In the case of the opened state where the upper unit **41** is slid over the lower unit **51** to the maximum, the folding-back portion **31***a* of the FPC board **31**, as shown in FIG. **6**(*b*), moves toward the rear end side from a portion near to the drawing-out port **56** of the concave space portion **55** to be housed in its concave space portion **56**. That is, as the drawing-out port **46** of the upper housing **42** slides toward the tip end portion (approaching the drawing-out port **56** of the lower housing **52**), the FPC board **31** between the drawing-out ports **46** and **56** changes a position where the folding-back portion **31***a* is formed so as to be positioned on the rear end side in the concave space portion **55** being deepest from the slant-inclined upper surface **52***a* and, therefore, the folding-back portion **31***a* is allowed to bend in a curvature that provides no load and its dimensions are so set as not to be exposed outside.

Thus, according to the second exemplary embodiment, the folding-back portion **31***a* of the FPC board **31** can be housed in the concave space portion **55** formed in the upper surface **52***a* serving as a slide facing surface of the lower housing **52** on the lower unit **51** side allowing the upper unit **41** to slide relatively in a slanting direction. As a result, space among the upper surface **52***a* and circuit substrates **24** can be used effectively without producing dead space, which ensures mounting space required for durability of the FPC board **31** therein without providing another space separately. Thus, in the second exemplary embodiment employing the structure allowing the upper unit **41** to be slid over the lower unit **51** in a slanting direction and, by preventing unnecessary large thickness of components, miniaturization and thinning can be achieved and, as a result, a user performing operations of the operation section **21***a* can see visually and easily the display portion **11***a*.

Third Exemplary Embodiment

FIGS. **7**, **8**(*a*), and **8**(*b*) are diagrams showing one example of a mobile phone of a third exemplary embodiment employing a sliding-type electronic device having a mounting structure of a flexible printed circuit of the present invention. FIG. **7** is a perspective view showing an outward appearance of the mobile phone. FIGS. **8**(*a*) and **8**(*b*) are side transparent views showing an FPC board to connect circuit substrates while upper and lower housings are in a sliding operation.

As shown in FIGS. **7**, **8**(*a*), and **8**(*b*), the mobile phone **60** is so configured that an upper unit **61** and a lower unit **71** are coupled by the FPC board **31** in a manner in which the upper and lower units **61** and **71** can overlie each other in the shape of thin rectangular parallelepiped structure and in a manner in which a lower surface **62***b* of the upper housing **62** of the upper unit **61** and an upper surface **72***a* of the lower housing **72** of the lower unit **71** can be freely slid in a longitudinal direction with the lower surface **62***b* and upper surface **72***a* being faced towards each other. A display portion **11***a* to display various information is placed on approximately the whole upper surface **62***a* of the upper housing **62**. In the lower unit **71**, an operation section (not shown) to perform an operation to input various information is disposed in a region on the upper surface **72***a* of the lower housing **72** exposing after having slid the upper unit **61**.

In the lower unit **71**, the height of a side surface (side wall portion) **72***c* of the lower housing **72** changes slant in a sliding direction and the upper surface **72***a* becomes higher on the rear end side in a slanted manner. In the upper unit **61**, similarly, the height of a side surface (side wall portion) **62***c* of the upper housing **62** changes slant in a sliding direction and the lower surface **62***b* becomes lower on the rear end side in a slanted manner. The lower surface **62***b* faces the upper surface **72***a* in a manner approaching each other. On the lower surface **62***b* of the upper housing **62** and on the upper surface **72***a* of the lower housing **72**, as in the above exemplary embodiments, grooved rails each having its cross-sectional shape of a key-shaped track and extruding rails are formed and the lower surface **62***b* and upper surface **72***a* can be slid, in a state in which the lower and upper surfaces face each other in an approaching manner, relatively in a longitudinal direction (in a slanting direction). That is, when the upper unit **61** and lower unit **71** are slid relatively from a closed state where the units **61** and **71** overlie each other to an opened state, the operation section on the upper surface **72***a* of the lower housing **72** can be exposed so as to be operable for inputting from a state being hidden against the lower surface **62***b* of the upper housing **62**.

In the upper unit **61**, a concave space portion **65** is formed through approximately the whole length from a portion near to the tip end side to a portion near to the rear end side in a longitudinal direction of the lower surface **62***b* of the upper housing **62**. The concave space portion **65** is so formed as to have a bottom surface **65***a* being parallel to a circuit substrate **14** and the upper surface **62***a* and a recessed shape being wider in width than the FPC board **31** and a drawing-out port **66** of the FPC board **31** is formed, in a shape of an aperture, on the rear end side. On the other hand, in the lower unit **71**, a concave space portion **75** is formed from a portion near to the rear end side to a portion near to a central position in the longitudinal direction of the upper surface **72***a* of the lower housing **72**. The concave space portion **75** is so formed as to have a bottom surface **75***a* being parallel to the circuit substrate **14** and upper surface **72***a* and a recessed shape being wider in width than the FPC board **31** and a drawing-out port **76** of the FPC board **31** is formed, in a shape of an aperture, on the tip end side (near the front). That is, the drawing-out port **66** of the upper housing **62** and the drawing-out port **76** of the lower housing **72** are formed on the end portion of the concave space portions **65** and **75** so that the ports **66** and **76** are not exposed to the outside even in the case of the state where the upper unit **61** and lower unit **71** overlie each other or even in the case of the state where the upper unit **61** is slid over the lower unit **71** to the maximum. Moreover, the drawing-out port **76** of the lower housing **72** is formed at a place facing the drawing-out port **66** of the upper housing **62** in an opened state where the drawing-out port **76** is slid to the maximum.

On the other hand, on the upper unit **61** side, the FPC board **31** extends, after being drawn from the drawing-out port **66** formed, in a shape of an aperture, on the rear end side of the concave space portion **65** of the upper housing **62**, up to the tip end side (up to over a portion near to a central portion) of the concave space portion **75** of the lower housing **72** facing the tip end portion of the concave space portion **75**. The FPC

board **31** on the lower unit **71** side extends, after being drawn from the drawing-out port **76** formed on the tip end side of the concave space portion **75** of the lower housing **72**, up to the rear end side (over a portion near to a central portion). The FPC board **31** has a folding-back portion **31***a* which is formed by being extended in the same direction between the tip end side of the concave space portion **65** on the upper unit **61** side and the rear end side of the concave space portion **75** on the lower unit **71** side.

Therefore, in the case of the closed state wherein the upper unit **61** and lower unit **71** overlie each other, the folding-back portion **31***a* of the FPC board **31**, as shown in FIG. **8**(*a*), is positioned in a portion near to the rear end side of the drawing-out port **76** of the concave space portion **75** and is housed in the concave space portions **65** and **75**. That is, the folding-back portion **31***a* of the FPC board **31** is positioned at a place having an intermediate depth in the concave space portion **65** and is allowed to bend in a curvature that provides no load and its dimensions are so set as to be housed therein.

Moreover, in the case of the opened state where the upper unit **61** is slid over the lower unit **71** to the maximum, the folding-back portion **31***a* of the FPC board **31**, as shown in FIG. **8**(*b*), moves from a portion near to the drawing-out port **76** of the concave space portion **75** to the rear end side and is housed in the concave space portions **65** and **75**. That is, as the drawing-out port **66** of the upper housing **62** is slid toward the tip end portion side (approaching the drawing-out port **76** of the lower housing **72**), the FPC board **31** existing between the drawing-out ports **66** and **76** changes the position where the folding-back portion **31***a* is formed so as to be positioned on the deepest rear end side in the concave space portion **75** and to gently bend in a curvature that provides small load and, therefore, the dimensions are set so as to prevent the exposure toward the outside.

Thus, according to the third exemplary embodiment, the upper unit **61** and lower unit **71** are slid relatively in a slanting direction and the lower surface **62***b* of the upper housing **62** faces the upper surface **72***a* of the lower housing **72** and the concave space portion **65** is formed on the lower surface **62***a* of the upper housing **62** and the concave space portion **75** is formed on the upper surface **72***a* of the lower housing **72**. As a result, space among the lower surface **62***b*, upper surface **72***a*, and circuit substrates **14** and **24** can be used effectively without producing dead space, which ensures mounting space required for durability of the FPC board **31** therein without providing another mounting space separately. Thus, in the third exemplary embodiment employing the structure allowing the upper unit **61** to be slid over the lower unit **71** in a slanting direction and, by preventing unnecessary large thickness of components, which can achieve miniaturization and thinning of the mobile phone.

Though various exemplary embodiments have been described in detail with reference to the figures, it is understood that the invention is not limited to these exemplary embodiments but may be changed and modified without departing from the scope of the invention. In the exemplary embodiments described above, examples are explained in which concave space portions to house the FPC board are formed on both the upper housing and lower housing facing each other in a manner in which each housing has more than a depth corresponding to a thickness of the FPC board, however, it is not necessary to say that the present invention is not limited to these and, when required space can be ensured, the concave space portion can be formed in one housing only. For example, in the above second exemplary embodiment, in the second exemplary embodiment, the concave space portion **45** may not have its depth.

In the above exemplary embodiments, one example is described in which the upper housing is slid over the lower housing in a longitudinal direction, however, the present invention is not limited to this and, for example, even when the housings are relatively moved rotationally in a positive or negative direction by using its one end portion as rotational-motion supporting point, the present invention can be applied to the case where a surface moving rotationally in a positive or negative direction is inclined.

The present application claims priority based on Japanese Patent Application No. 2008-299082 filed Nov. 25, 2008, the entire contents of which are incorporated herein by reference in its entirely.

INDUSTRIAL APPLICABILITY

The present invention can be widely applied not only to mobile phones but also electronic devices having a sliding mechanism, for example, portable electronic terminals such as notebook type personal computer, PDAs (personal digital assistants), digital cameras, and digital video cameras.

EXPLANATION OF LETTERS AND NUMERALS

10, **40**, and **60**; Mobile phone (portable electronic device)
11*a*; Display portion
12, **42**, and **62**; Upper housing (first housing)
12*b*, **42***b*, and **62***b*; Lower surface (Slide facing surface)
12*c*, **22***c*, **52***c*, **62***c*, and **72***c*; Side surface (side wall portion)
13; Grooved rail
14 and **24**; Circuit substrate
15, **25**, **45**, **55**, **65**, and **75**; Concave space portion
16, **26**, **46**, **56**, **66**, **76**; Drawing-out port
21*a*; Operation section
22, **52**, and **72**; Lower housing (second housing)
22*a*, **52***a*, and **72***a*; Upper surface (slide facing surface)
23; Extruding rail
31; Flexible printed circuit (FPC) board
31*a*; Folding-back portion

What is claimed is:

1. A mounting structure of a flexible printed circuit board comprising:

a flexible printed circuit board folded back and routed between slide facing surfaces of a first housing and a second housing both being mechanically coupled to each other in a manner being freely slidable to electrically connect said first and second housings wherein a height of a sidewall surface making up at least one of said first and second housings changes in a bending manner along a freely slidable direction; and

a concave space portion on one slide facing surface making up at least one of said first and second housings to accommodate flexible changes in folding-back curvature and folding-back position of said flexible printed circuit board caused by sliding motion between said first and second housings,

wherein a depth of said concave space portion changes in a bending manner along a freely slidable direction;

wherein said flexible printed circuit board is always folded back toward an opposite direction to a direction of sliding open motion, irrespective of sliding state between said first and second housings, and

wherein a folding-back portion of said flexible printed circuit board appears as a minimum curvature, even when said slide facing surfaces are in a maximum opened sliding state.

2. The mounting structure of the flexible printed circuit board according to claim 1, wherein first and second drawing-out ports to draw out said flexible printed circuit board between said slide facing surfaces of said first and second housings are formed respectively on said, in such a manner that the drawn-out flexible printed circuit board is housed on said slide facing surfaces in a facing region even when said slide facing surfaces are in said maximum opened sliding state.

3. A sliding-type electronic device comprising: a flexible printed circuit board folded back and routed between slide facing surfaces of a first housing and a second housing both being mechanically coupled to each other in a manner being freely slidable to electrically connect said first and second housings wherein a height of a sidewall surface making up at least one of said first and second housings changes in a bending manner along a freely slidable direction; and

a concave space portion on one slide facing surface making up at least one of said first and second housings to accommodate flexible changes in folding-back curvature and folding-back position of said flexible printed circuit board caused by sliding motion between said first and second housings,

wherein a depth of said concave space portion changes in a bending manner along a freely slidable direction;

wherein said flexible printed circuit board is always folded back toward an opposite direction to a direction of sliding open motion, irrespective of sliding state between said first and second housings, and

wherein a folding-back portion of said flexible printed circuit board appears as a minimum curvature, even when said slide facing surfaces are in a maximum opened sliding state.

4. The sliding-type electronic device according to claim 3, wherein first and second drawing-out ports to draw out said flexible printed circuit board between said slide facing surfaces of said first and second housings are formed respectively on said, in such a manner that the drawn-out flexible printed circuit board is housed on said slide facing surfaces in a facing region even when said slide facing surfaces are in said maximum opened sliding state.

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